

1 SUMMARY AND PURPOSE AND NEED FOR THE PROPOSED ACTION

This Final Environmental Impact Statement for the Outrigger Telescopes Project has been prepared by the National Aeronautics and Space Administration (NASA) to assist in the decision-making process in accordance with the National Environmental Policy Act of 1969, as amended (NEPA) (42 U.S.C. §4321 et seq.) and NASA's policy and procedures (14 CFR Subpart 1216.3).

1.1 SUMMARY OF THE PROPOSED ACTION AND PREFERRED ALTERNATIVE

The National Aeronautics and Space Administration (NASA) is proposing to fund the on-site construction, installation, and operation of four, and possibly up to six, Outrigger Telescopes at the W.M. Keck Observatory site, NASA's preferred alternative, located within the Astronomy Precinct of the Mauna Kea Science Reserve on the island of Hawai'i.

The State of Hawai'i leases the Mauna Kea Science Reserve to the University of Hawai'i (UH). UH subleases the W.M. Keck Observatory site to the California Institute of Technology (Caltech). The California Association for Research in Astronomy (CARA), a non-profit corporation established by the University of California and Caltech, operates and maintains the Keck Telescopes and the W.M. Keck Observatory site.

1.2 PURPOSE AND NEED FOR ACTION

Since its inception in 1958, NASA has achieved countless scientific and technological breakthroughs in air and space science and technology. NASA continues to be a driving force in scientific research and in stimulating public interest in space science and exploration.

NASA has a central Mission with three components: (1) to understand and protect

our home planet, (2) to explore the universe and search for life, and (3) to inspire the next generation of explorers. The second component, to explore the universe and search for life, addresses two of humanity's oldest and most profound questions: "Where did we come from?" and "Are we alone?" Understanding where we come from requires knowledge of how today's universe of galaxies, stars, and planets came to be, and how stars and planetary systems form and evolve. Understanding whether or not we are alone requires knowledge about the building blocks of life, the conditions necessary to sustain life, and the diversity of planets—particularly those that might harbor life. Acquiring knowledge in all of these areas is the goal of NASA's Origins Program. In pursuit of this knowledge, NASA supports space flight missions, related research programs, and technology development.

Interferometry is a critical technology for accomplishing the Origins Program. It is a technique for overcoming an inherent limitation of single telescopes: the "sharpness" or amount of image detail is limited by the size of the telescope's main mirror. An interferometer combines two or more telescopes optically so they function as if they were a single larger telescope. The number of individual telescopes and the distance between them determines the sharpness of the image from an interferometer. Because the separation between telescopes can be much larger than

the diameter of even the largest telescope mirrors, interferometers in general acquire images that capture much more detail than individual telescopes.

Interferometers also can measure positions of stars with exquisite accuracy. This is important because it is possible to find planets around other stars by measuring the stars' positions very accurately over a substantial period of time. As a planet orbits a star, it exerts a gravitational tug that causes the star to move back and forth. An interferometer can detect this slight "wobble," thus revealing the presence of the orbiting planet.

NASA is developing interferometry for use both in space and on the ground. Space flight missions, such as the Space Interferometry Mission scheduled for launch in 2009, can achieve even finer measurements than are possible from the ground by getting above the Earth's atmosphere to avoid its image distortion. However, ground-based interferometers are essential for projects that require a longer operating life than is possible with a space flight mission. They can also involve telescopes that are larger and more sensitive than the ones that can be flown in space.

The Outrigger Telescopes Project is part of NASA's program to develop ground-based interferometry. The project as proposed addresses four of NASA's six scientific objectives for ground-based interferometry. These six objectives are:

1. Detect the thermal dust emissions from dust clouds around other stars.
2. Detect the light from and characterize the atmospheres of hot, Jupiter-mass planets located within approximately 20 million kilometers (km) (12 million miles (mi)) of the stars they are orbiting.

3. Detect the astrometric signature (*i.e.*, the wobble of a star due to the gravitational influence of an unseen planetary companion) of planets as small as Uranus.
4. Make images of proto-stellar disks (*i.e.*, disks of dust and gas in space believed to be an early stage of star formation) and stellar debris disks (*i.e.*, clouds of gas or other material remaining after the star is formed).
5. Provide high-resolution information about some faint objects outside our galaxy.
6. Make high-resolution observations of objects within the solar system, including asteroids, comets, and outer planets.

The first two objectives can be accomplished by the Keck-Keck Interferometer which links the two 10-meter (m) (33-foot (ft)) Keck Telescopes. Objectives 3 through 6 require the Outrigger Telescopes. Objective 3, finding planets around nearby stars by means of astrometry, can be accomplished with four Outrigger Telescopes alone. Objectives 4 through 6 require that the Outrigger Telescopes be connected to one or more large (8-m (26-ft) diameter or larger) telescopes. Six Outrigger Telescopes would provide almost twice as much image detail as four in pursuit of Objectives 4 through 6, yielding much higher quality scientific data.

The Outrigger Telescopes Project would also support a key Origins Program flight mission, the Terrestrial Planet Finder. The Terrestrial Planet Finder, scheduled for launch sometime in the second decade of this century, would undertake the extraordinarily difficult task of separating the light of a terrestrial (Earth-like) planet orbiting another star from the light of its

parent star. It then would measure the spectrum of the planet's light to determine the planet's properties and determine if it might be capable of supporting life. Finding and characterizing the best possible target stars for the Terrestrial Planet Finder to examine is crucial to the success of the mission. By undertaking Objective 3, finding larger planets around nearby stars, the Outrigger Telescopes Project would contribute to our understanding of planetary system architectures and help characterize stars to be examined with the Terrestrial Planet Finder.

In order to enhance this nation's capabilities to pursue the answers to the age-old questions concerning the origin of life and whether life exists on other planets, NASA must further develop and refine interferometry. Accordingly, NASA, as the Federal agency charged with exploring the universe, has an interest in developing experience and expertise within the American astronomical community in the design and operation of ground-based interferometric arrays. One of the purposes of the Outrigger Telescopes Project is to provide American astronomers opportunities to develop this expertise.

1.3 FEDERAL ENVIRONMENTAL PLANNING ACTIVITIES TO DATE

Federal Processes. Pursuant to the National Environmental Policy Act (NEPA), NASA completed an Environmental Assessment (EA) for the Outrigger Telescopes Project in February 2002 and issued its decision document (Determination of Required Mitigation and Decision) on March 4, 2002.

In addition to its NEPA activities, NASA conducted consultations in accordance with Section 106 of the National Historic

Preservation Act of 1966, as amended (NHPA) (16 U.S.C. § 470 *et seq.*). NASA began this process in July 1999 by authorizing UH to begin working-level consultations on behalf of NASA. UH, in consultation with the Hawai'i State Historic Preservation Division (SHPD), contacted a number of Native Hawaiian organizations to determine their interest in participating in the Section 106 process. In November 1999, a NASA representative met with the Hawai'i Island Burial Council. In August 2000, NASA formally provided copies of draft mitigation proposals to the State Office of Hawaiian Affairs, the Royal Order of Kamehameha I, the Hawai'i Island Burial Council, and Hui Mālama I Nā Kūpuna O Hawai'i Nei, and invited them to join with NASA and the SHPD in formal consultation under the Section 106 process as Consulting Parties. In September 2000, NASA formally invited the Advisory Council on Historic Preservation (ACHP) to join in the Section 106 process. The ACHP agreed to participate.

NASA consulted with and invited the Office of Mauna Kea Management, the Mauna Kea Management Board, and Kahu Kū Mauna Council to participate in developing a Memorandum of Agreement (MOA) under Section 106. Two more Native Hawaiian organizations, Ahahui Kū Mauna and Mauna Kea Anaina Hou, requested and were given Consulting Party status. NASA held formal Section 106 meetings in Hilo on February 1, 2001, and again on January 16 and 17, 2002. NASA completed the Section 106 consultation process February 22, 2002 with the signing of an MOA by NASA, ACHP, SHPD, CARA, Caltech, UH, and Ahahui Kū Mauna (with caveat).

The Office of Hawaiian Affairs challenged NASA's EA and decision in Federal Court. In June of 2003 the court remanded the EA and instructed NASA to reassess the

cumulative impacts of the proposed Outrigger Telescopes Project. In November of 2003, NASA announced its decision to voluntarily go beyond the Court's direction to reassess cumulative impacts in a new Environmental Assessment. NASA announced that it would instead prepare an Environmental Impact Statement (EIS). NASA's decision to prepare an EIS recognized the deep concerns and feelings expressed for Mauna Kea by members and representatives of the Native Hawaiian community. On December 30, 2003, NASA published its Notice of Intent (NOI) to prepare an EIS in the Federal Register (68 Federal Register (FR) 75285). The NOI was also published in the *Honolulu Star-Bulletin*, *Hilo Tribune*, *West Hawaii Today*, the *Honolulu Advertiser*, and the *Pasadena Star News*. NASA held five public scoping meetings on the islands of Hawai'i and O'ahu in January 2004 and accepted public scoping comments until February 16, 2004.

NASA received many comments during the public scoping period, both orally at the public scoping meetings and in written submissions. The comments addressed issues included under NEPA and issues not so included. The latter were deemed out-of-scope for this EIS. The in-scope issues raised were primarily:

- Cultural impacts
- Hazardous materials handling
- Hydrology
- Visual impacts to the view planes to and from Mauna Kea
- Impacts to the Wēkiu bug and its habitat, and overall cumulative impacts to the summit region (the Wēkiu bug is a candidate for listing under the Endangered Species Act of

1973, as amended (16 U.S.C § 1531 *et seq.*).

The EIS analysis focuses particularly on these areas.

Numerous comments were received on topics deemed out-of-scope for this EIS. These included, but were not necessarily limited to,

- The amount of lease rent (\$1/year) formally received by the University from each observatory on Mauna Kea
- The overall management structure for the mountain
- The status of the 2000 Master Plan for the Mauna Kea Science Reserve, particularly the issue of approval by the Department of Land and Natural Resources
- The Conservation District Use Application by UH proceeding concurrently with the federal EIS process
- The relationship between NASA and the Department of Defense
- The generation and distribution of income from ceded lands
- The overthrow of the Hawaiian monarchy.

Many parties described the sanctity of the land and other aspects of the natural environment in Native Hawaiian culture. Comments were made frequently on the particular sanctity of the Mauna Kea summit region. In recognition of this sanctity, NASA made particular effort to obtain comments and perspectives from Native Hawaiian religious practitioners (see Section 3.1.2.5 for more details).

Many also expressed concern about past management practices on Mauna Kea. Several discussed strained relationships with other governmental organizations (e.g., the Department of Defense), and expressed heartfelt concern about the ability of Native Hawaiians to respond to the many assaults they see being made upon their culture and heritage.

On July 29, 2004, NASA published its Notice of Availability (NOA) for the Outrigger Telescopes Project Draft EIS in the Federal Register (69 FR 47926). The NOA was also published in the *Honolulu Advertiser*, the *Garden Island Newspaper*, *Honolulu Star-Bulletin*, the *Maui News*, *Hawai'i Island Tribune*, *West Hawaii Today*, *Hawai'i Island Journal*, and the *Pasadena Star News*.

The public comment period began August 6, 2004 and ended September 30, 2004. Six public meetings were held on the islands of Hawai'i, O'ahu and Maui in late August/early September 2004. Appendix G, Volume II provides the summaries of oral comments and the verbatim comments and responses to written comments.

1.4 ORGANIZATION OF THE EIS

This EIS is organized into two volumes. Volume I contains Chapters 1 through 10, and Volume II contains Appendices A through G.

Chapter 2 describes the Proposed Action and addresses the results of NASA's consideration of alternative sites for the Outrigger Telescopes Project. Chapter 2 identifies a reasonable alternative site for the Outrigger Telescopes Project on La Palma in the Canary Islands.

Chapter 3 provides a comprehensive description of the environment at and near the W.M. Keck Observatory site.

Chapter 4 addresses the environmental impacts of the Proposed Action, including the cumulative environmental impacts of implementing the Proposed Action. It considers past, present, and reasonably

VOLUME I	
Chapter 1	Summary and Purpose and Need for the Proposed Action
Chapter 2	Proposed Action and Alternatives
Chapter 3	Affected Environment
Chapter 4	Environmental Impacts
Chapter 5	Mitigation and Monitoring Measures for the Outrigger Telescopes Project
Chapter 6	Reduced Science Options
Chapter 7	List of Preparers
Chapter 8	Agencies, Organizations, and Persons Consulted
Chapter 9	Index
Chapter 10	References

foreseeable future activities within or near the Mauna Kea Astronomy Precinct.

Chapter 5 provides a description of the numerous mitigation commitments made by NASA, CARA, and UH in implementing the Outrigger Telescopes Project.

If NASA, in the Record of Decision for this EIS, should decide not to fund the Proposed Action at Mauna Kea or at a reasonable alternative site, NASA would consider the option of implementing the Outrigger Telescopes Project at an existing U.S. observatory facility where only reduced science returns would be possible. This is called the Reduced Science Option. Two potential reasonable observatory sites have been identified for this option, Mount Wilson, California and Palomar Mountain, California. The Reduced Science Option

would achieve only one scientific objective of the Outrigger Telescopes Project. Chapter 6 addresses the environmental impacts of constructing and operating the Outrigger Telescopes at each of the two reduced science sites.

Chapters 7 through 10 contain a list of preparers of this EIS, entities consulted during EIS preparation, an index to key topics in the EIS, and the references used in preparing the document.

Volume II of this EIS contains Appendices A through G, which provide detailed and/or focused information relative to key environmental impacts and topics addressed in Volume I. Appendix A contains letters received by NASA during coordination with State agencies for the Outrigger Telescopes Project. Appendix B provides the National Historic Preservation Act Section 106 Memorandum of Agreement. Appendix C contains a Burial Treatment Plan that has been reviewed by the Hawai'i Island Burial Council. Appendices D and E, respectively, contain the Wēkiu Bug Mitigation and Monitoring Plans. Appendix F contains the Construction Best Management Practices Plan. Appendix G provides the responses to oral and written comments on the Draft EIS.

VOLUME II	
Appendix A	Reference Correspondence
Appendix B	Memorandum of Agreement
Appendix C	Burial Treatment Plan
Appendix D	Wēkiu Bug Mitigation Plan
Appendix E	Wēkiu Bug Monitoring Plan
Appendix F	Construction Best Management Practices Plan
Appendix G	Response to Comments

1.5 COMPREHENSIVE SEARCH FOR ENVIRONMENTAL INFORMATION

The preparers of this EIS conducted a comprehensive search for environmental information on past and present activities on Mauna Kea. The following are the principal environmental documents reviewed:

1. General Lease #S-4191. Signed June 21, 1968 (65-year lease of Mauna Kea summit).
2. *CFHT Final Environmental Impact Statement Proposed Telescope and Observatory Facilities*. Prepared by Neighbor Island Consultants, May 1974.
3. *UH/IRTF/UKIRT Final EIS*. Prepared by University of Hawai'i, May 1975.
4. *Environmental Impact Analysis of the NASA Infrared Telescope Facility at Mauna Kea, Hawaii*. Prepared by Booz-Allen Applied Research, July 1975.
5. *Hale Pohaku: Mid-Elevation Facilities Master Plan Revised Environmental Impact Statement*. Prepared by Group 70, February 1980.
6. *10-Meter Telescope for Millimeter and Submillimeter Astronomy at Mauna Kea, Hamakua, Hawaii: Final Environmental Impact Statement*. Prepared by Group 70, August 1982.
7. *Mauna Kea Science Reserve: Complex Development Plan—Final EIS*. Prepared by Research Corporation of the University of Hawai'i, January 1983.
8. *Amendment to the Mauna Kea Science Reserve Complex Development Plan—Final Supplemental Environmental Impact Statement for Construction Camp Housing*. Prepared by MCM Planning, October 1985.

9. *Saddle Road Improvements, CDUA, CDUA Supplement and Environmental Impact Assessment.* County of Hawai‘i, June 1986.
10. *Amendment to the Mauna Kea Science Reserve Complex Development Plan: Final Supplemental EIS—VLBA Antenna Facility.* Prepared by Research Corporation of the University of Hawai‘i, September 1988.
11. *Project Description: Japan National Large Telescope (JNLT).* Prepared by MCM Planning, January 1991.
12. *Project Description: Gemini 8-Meter Telescopes Project.* Prepared by Townscape, Inc., July 1992.
13. *Environmental Assessment for the Gemini Northern 8-Meter Telescope.* Prepared by Engineering-Science, Inc., December 1993.
14. *Project Description and Environmental Review: Smithsonian Astrophysical Observatory Submillimeter Array Telescope.* Prepared by MCM Planning, January 1994.
15. *Project Description and Environmental Review: GTE Hawaiian Telephone Company Fiber Optic Cable Project—Pohakuloa to Hale Pohaku Link.* Prepared by MCM Planning, September 1995.
16. *Mauna Kea Ranch Pipe Line, Hamakua Coast, Hawaii, Final Environmental Assessment.* Prepared by Waimea Water Services Inc. Mauna Kea Ranch John Hancock Insurance, August 1996.
17. *Final Environmental Assessment/Finding of No Significant Impact, Saddle Road Well A.* Prepared by Planning Solutions, Inc. Department of Water Supply, County of Hawai‘i, November 1997.
18. *Project Description and Environmental Review: Temporary Optical Test Sites for the W.M. Keck Observatory Twin Keck Telescope Interferometer.* Prepared by MCM Planning, March 1998.
19. *Final Environmental Assessment: Temporary Optical Test Sites for W.M. Keck Observatory Twin Keck Telescope Interferometer.* Prepared by MCM Planning, September 1998.
20. *Environmental Impact Statement Preparation Notice, Saddle Road Extension: From Mamalahoa Highway to Queen Ka‘ahumanu Highway.* Department of Transportation, July 1999.
21. *Mauna Kea Science Reserve Master Plan, Final Environmental Impact Statement.* University of Hawai‘i, December 1999.
22. *Mauna Kea Science Reserve Master Plan.* University of Hawai‘i, June 2000.
23. *Final Environmental Assessment for the Outrigger Telescopes Project.* NASA, March 2002.
24. *Final State Environmental Assessment for Mauna Kea Astronomy Education Center.* University of Hawai‘i, August 2002.

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